Interim Progress Report submitted to
NOAA's Human Dimensions of Global Change Research (HDGCR) Program

Project Title: Climate, Water Scarcity and Management in Brazil and Chile

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A. Abstract

This comparative study examines the use of seasonal climate forecasting in water management in Brazil and Chile, two countries where a better understanding of climate variability may be critical to mitigating the effects of water scarcity. Both countries have initiated broad water reform programs which promote decentralized water resource management, and in the Brazilian case, integrated and environmentally sustainable management. Legislation in both countries stipulates that water is an economic good for whose use users should pay. Under these circumstances, the use of seasonal climate information can play a critical role in water management by allowing for pro-active planning and decisionmaking. However, technical and scientific (especially climate) information enters into watershed-level decision making in different ways, varying both with institutional design and pre-existing problem definitions. We must therefore disaggregate these, making it possible to identify and decipher characteristic patterns of combinations and their association with processes and outputs of water management institutions. Institutional patterns act as filters that determine how information is received and used. We have undertaken extensive institutional analysis of the water sector in both countries, focusing on the following research questions: What aspects of the structure, composition, procedural norms, or other aspects of institutional design and practice facilitate the incorporation of innovation (science-based information) in decision-making processes? How does the use of science-based knowledge affect decision-making within these institutions? How is such information presented, communicated, and how is it made operational? Does private ownership of water rights make actors more likely to seek out such information? Does use of scientific information support (through increasing transparency and accountability) or hinder (by promoting technocratic insulation) democratic decision-making processes? To answer these questions this project will compare the use of seasonal climate forecast across six

watersheds, three in Brazil and three in Chile The study will combine quantitative analysis based on our surveys of decision-makers with qualitative methods (in-depth interviews with key informants and documentary research) to investigate the uses (actual or potential) of seasonal climate forecasting in decision-making at the watershed level.

In Brazil, we are collaborating with researchers involved in the Watermark Project, a multi-year study of factors affecting institutional innovation and consolidation of participatory watershed-level management institutions. The project has a commitment to share findings continuously with the groups and organizations being studied including watershed-based committees, government organizations, and the public. In Chile, we are building upon research already in progress within a NOAA funded project comparing the use of seasonal climate forecasting in agriculture and drought planning in the Limarí River basin in Region IV, one of the driest in the country as well as in two other watersheds located to the south of the capital city of Santiago. All three watersheds in Chile share a common institutional framework, but show different levels of economic development, conflict, and use of techno-scientific information.

B. Objectives:

The goal of this study is to understand how policymakers and other users adopt and apply techno-scientific information, especially seasonal climate forecasting, in the management of water resources in Brazil and Chile. In order to accomplish that, we are carrying out extensive institutional analyses of the Brazilian and Chilean water management systems. We target both policymakers and direct resource users to build a broad database on the perceptions and use of climate information. We will develop a model for institutional analysis at the level of watershed decision-making through the analysis of six sets of variables:

- social political setting (federalism, political culture, level of decentralization)
- nature of the problem (physical characteristics, complexity, level of permanent structures, conflict/crisis)
- Individual values (paradigms, ideas, personal values)
- institutional complexity (Laws, norms, rules, overlapping jurisdictions, accountability, authority)
- organization culture (flexibility, accountability, capacity, resources)
- knowledge 'fit' (relevance, credibility, legitimacy)

C. Approach:

We focus on three watersheds in each country, taking into consideration the following factors:

a. In each country, we selected watersheds located in regions with comparable geoclimatic characteristics and under similar climatic fluctuations, that is, drought in Northern Chile and Northeast Brazil and flooding in the South. These watersheds are good representatives of the kind climatic stress and ecological conditions existing in a few regions of both countries;
b. Brazilian policymakers in the study area are actively implementing policies to move water management, towards a more decentralized, integrated,

participatory and environmentally sustainable watershed-based water management system. Chile has had a decentralized water system since the 1980's, but some policy makers are attempting to modify the Water Code in order to promote a more ecologically conscientious use of water. The amendment to the water code was finally approved some few weeks ago, so we plan to take advantage of the timing of our second field campaign (Summer 2005) to carry out research on the potential impacts of these changes (that are aimed at avoiding speculation with water rights and higher environmental protection).

c. In all cases, agriculture and industry (including electricity) are the activities most vulnerable to climate variability;
d. The study regions are prone to drought and flooding associated with seasonal climate phenomena, such as El Niño/La Niña;
e. In both countries, conflict over water use by multiple users has become one of the most pressing issues on the governmental agenda.

We are proceeding inductively, testing loosely defined hypotheses in different socio-economic and institutional contexts. We use a multi-method approach that combines quantitative and qualitative research methods such as surveys, semi-structured, in-depth interviews, secondary analysis of national data, and personal observation, and interpretation of findings in relation to their wider social contexts. We recognize that the two levels of comparison (among different basins in each country and cross-national between Chile and Brazil) adds more complexity to the research. However, although we expect some variability from one national sample to the other, we trust that the richness provided by the ethnography of each of the basins selected for this study will outweigh whatever clarity we lose in general empirical propositions. On the other hand, by focusing on three basins in each country, we seek to maximize comparability by avoiding too different institutional settings (although this is less the case in "federalized" Brazil than in more centralized Chile). Similarly, because of the limitations inherent to research where small number of cases is studied, we focus on "comparable cases" that is, "similar in a large number of important characteristics (variables) which one wants to treat as constant, but dissimilar as far as those variables are concerned which one wants to relate to each other" (Lijhart, 1971:687).

In this study, we propose to employ a combination of qualitative and quantitative methods and techniques to examine the following research questions:

- What aspects of a region's developmental trajectory and institutional history make users and/or policymakers more likely to seek out technical information on their own to bolster their positions?
- What aspects of the structure, composition, procedural norms, or other factors in institutional design and practice, make institutions more able to incorporate innovation (science-based information) in decision-making processes?
- How does the use of science-based knowledge affect decision-making within these institutions?
- How is such information presented, communicated, and how is it made operational?
- Does private ownership of water rights make actors more likely to seek out such information? Does use of scientific information support (through increasing

transparency and accountability) or hinder (by promoting technocratic insulation) democratic decision-making processes?

The field team is carrying out in-depth interviews with policy and decision-makers at the watershed, state, and federal level where relevant for each of the case studies selected. Key informants have been identified through purposeful, opportunistic sampling where individuals "snowball," or refer, to other individuals, and the original list of persons consulted grows according to recommendations of the interviewees themselves. In this case, snowball selection is appropriate because, rather than formal hypothesis testing, the main goal of such interviews is to gauge policymakers' perceptions of their constraints and opportunities for using climate information in decision-making. In addition, we plan to apply a user survey so as to cross check information and understand users' perception of how information affects their ability to participate in decision making.

The research will contribute to scholarship in Policy Sciences, Environmental Sciences, Social Studies of Science, and environmental studies within the social sciences more generally. Our focus on information flows and the interplay of technical and practical knowledge in institutional development, long a research focus for Lemos, has significant importance for the study of science and society and for development studies. By paying a great deal of attention to the development of informal practices in organizations, as well as to information flows and decision-making within and among them, we hope to contribute to the literature on political learning to which Keck has made significant contributions. By examining of the complexity/simplicity both of the organizations that deal with hydropower generation—to which the Chilean law give precedence during crises, and which are present in two of the three Chilean basins—and of other organizations related to water management in Chile (e.g., irrigators associations, some few farmers who receive real-time climate information from the local university), we hope to contribute to increase our understanding of the final water consumers' satisfaction under free market conditions.

D. Matching Funds:

This study collaborates with the Watermark project in Brazil, coordinated by Keck. The Watermark Project was set up to take advantage of the more or less simultaneous organization of decentralized watershed management institutions in most Brazilian states. It has received funds from the McArthur foundation, Hewlett Foundation and the Brazilian Ministry for Science and Technology (through CT-Hidro). It aims to generate broadly comparative data, over time, about a set of questions of interest to both scholars and practitioners, and to provide a space for an ongoing exchange of views and information. In addition, this studies leverages funds with NSF through a grant awarded to Lemos.

II Interactions:

A. With policymakers: in Year One (Summer 2004) we interviewed water and reservoir managers, and Watershed Committee members in the watersheds selected in addition to two other watersheds, one in the state of Bahia and another in the state of Rio Grande do Sul, taking advantage of comparative research being carried out by two PhD students involved in the project. In addition, the Watermark Project involves constant interaction with those policymakers who participate in it, most of whom have been deeply involved with the water reform project in Brazil. Since we were not able to take advantage of Summer field research in Year One due to a delay in the availability of funds, we plan to continue field research this Summer (2005) concentrating in the Paraiba do Sul basin. The latter is the most complex and straddles through three states making field research more difficult logistically. We plan to complete the interview process by next Summer's end.

In Chile, the research team is interacting closely with the National Commission for Irrigation. The NCR is in charge of the administration of several economic instruments that the government has designed to improve efficiency of irrigation water utilization. This agency is also implementing a program aimed at fostering water users organizations and use of technical information. In this sense, the NCR will add research questions to our project. This will ensure the applicability of some of our findings.

We are currently designing a written agreement between the University of Chile and the NCR that will allow for official collaboration and data exchange.

The planned workshop in Chile considers the participation of public servants and politicians involved in water issues. Because of the Water Code amendment, there are preliminary conversations with the UN Economic Commission for Latin America and the Caribbean (ECLAC) in order to organize a large workshop with the participation of irrigators/water managers from Argentina and Brazil.

Additionally, we will negotiate with local authorities in Brazil extra funding for organizing local workshops in each of the studied watersheds.

B. With the climate community: the study also includes interviewing climate forecasters located in Santiago de Chile and in a few of the watersheds selected in Brazil.

C. With other NOAA projects: the study builds on previous research funded by NOAA in which both Leon and Lemos have been involved. It is also collaborating with another on-going project (originating at IRI) to understand the use of seasonal climate forecasting in NE Brazil (Kenny Broad, PI).

III Accomplishments:

As mentioned above, field activities programmed for the Summer of 2003 were not carried out until 2004. Thus from April/04 to April/05 the main activities under this award were:

- Continued literature review of related themes, especially decision science, theory of institutions and institutional change, and co-production of science and policy.
- Conclusion of two Master's Theses partially funded by this project and advised by Lemos:
    - Andrea Ballesteros' thesis focused on institutional adaptation in the Lower Jaguaribe River Basin (one of our case studies) and was concluded in December 2004.
    - Lori Kumler's thesis focused on social learning and water management—especially drought management—in the Paraiba do Sul River Basin (another of our case studies) and was concluded in April 2005.
- In collaboration with the Watermark Project, the Co-PIs designed, pre-tested and carried out (with the support of the Federal University of Minas Gerais) a broad survey of Watershed Committee members across 18 basins. The survey concluded in January 2005 and is currently at the stage of data "cleaning", organization and preliminary analysis. The survey's purpose is to assess the conditions under which these forums adopt democratic practices and become effective water management organizations. It will test the significance of several different kinds of variables for explaining participation and the ability to reach agreement on goals, including individual characteristics and beliefs (socio-economic status, area of specialization and worldviews), organizational processes (such as the role of leadership and the use of technical information), external context (such as socio-economic conditions). It also collects data helping measure the level of democracy and effectiveness of the organizations, recognizing that these characteristics cannot be fully captured through survey analysis, which must be complemented with qualitative work. Finally, the survey includes a small battery of questions intended for network analysis, rather than the multivariate treatment . The survey contains modules on socioeconomic characteristics, organization, participation, world views, cohesion, and use of information. The Information Use module was designed specifically to address questions pertinent to this study, including past use of seasonal climate forecasting, perception of potential future use, perception of its relevance, accessibility and skill, and perception of impacts of the use of technical information on issues of democracy, accountability and ability to make decisions.
- To ensure comparability, the Chilean research team is utilizing the original survey designed in Brazil. Due to the differences in the institutional setting and non-existence of the "basin" as a management unit, the survey was adapted to the local conditions.
- Leon supervised and advised the design of José Miguel Arriaza's project, a Natural Resources Engineer research project. This study is currently underway in the Maule River basin, and the final report is been prepared.

- In the Maule River basin key stakeholders were contacted in order to initiate the "snowballing" process. Likewise, the research team attended a technical meeting hosted by the University of Talca during late 2003, where fresh fruit growers who are current users of techno-climate information provided by that university were contacted.
- Rodrigo Fuster, faculty at the University of Chile and currently a graduate student in the Environmental Sciences Ph.D. Program at the Universidad Autonoma de Barcelona, Spain, will initiate the interviewing process in the (dry) Limari basin during July. Fuster was co-PI of a IWMI funded project that examined the relationship between public investment in irrigation infrastructure and the decrease of rural poverty in this basin. Hence, he already ahs a deep knowledge of the basin's reality.
- Leon is supervising and advising the design of Fabiola Arcos' project, a Natural Resources Engineer research project. This study is currently underway in the Ñuble basin. This basin as a low level of conflict since is primarily devoted to agriculture. Nonetheless, lack of climate information has deterred investments in agriculture since water supply decreases sharply by the end of November.
- In Chile, a fourth basin, the BioBio, will be added to the study. The BioBio is the largest basin in the country and contains one of the largest industrial and urban areas. There is also some agriculture. Therefore, the basin experiences conflicts of different nature and intensity.
- At the central level, the team has interviewed several of the central figures within the forecasting community. Leon will continue interviewing policy makers at this level.
- Keck is supervising the work of three Johns Hopkins doctoral students whose individual dissertation projects make them particularly apt collaborators in this study:
    - Anna Gruben spent between January and April, 2004, in the state of Bahia, in the Brazilian northeast. She divided her time between interviewing in and observing activities of one river basin committee in the sertão, interviewing state officials in Salvador, the state capital, and interviewing participants while observing the creation of another committee several hours from Salvador.
    - Jennifer Lalonde spent the month of July 2004 in Pernambuco, both in the capital Recife and in the interior. She interviewed state officials and water users, in Recife and also along the Pirapama River Basin Committee.
    - Ricardo Gutierrez has received a stipend from 5/04 to 3/05, and will receive two additional months. He has done field studies in the states of Ceará and Rio Grande do Sul, and is about to do one in the state of Paraná. He has also done more general research on attitudes, goals, and activities of technical personnel involved in implementing the new system of water management.
- As was foreseen in the work plan, Keck and Lemos were heavily involved in design of the Watermark Project's national survey questionnaire. In addition, besides collaborating in the general design and multivariate analysis, Keck will be primarily responsible for the network component. To that end, she has worked on her quantitative network analysis skills with specialists at the Johns Hopkins School of Public Health and at Rutgers University. For our purposes

here, the network analysis will be particularly useful in identifying and assessing both the robustness and the reach of the pathways along which technical information is likely to flow.

- Keck and Lemos will spend a considerable part of the summer 2005 in Brazil, carrying out fieldwork relevant for this study and working on the analysis of the subnational survey data.
- Lemos has published two articles on themes related to this project:
    - Lemos, M. C. and J. L. F. Oliveira (2005). Water reform across the state/society divide: the case of Ceará, Brazil. *International Journal of Water Resources Development*, vol. 21, no. 1, pp. 93-107.
    - Lemos, M. C. and J. L. F. Oliveira (2004). "Can Water Reform Survive Politics? Institutional Change and River Basin Management in Ceará, Northeast Brazil. *World Development*, Vol. 32, No. 12, pp. 2121-2137.

IV. Relevance to the field of human-environment interactions

A.

- We expect the research on decision-making to generate both a data-base of decisions and an analytical report that, by means of the comparison between two countries, highlights both the strength and weaknesses of the current institutional framework and dominant organizational culture;
- We expect to build a theoretical model of seasonal climate information use among water mangers and other users which can inform data producers not only of the needs but also of the best strategies to communicate and 'package' climate forecasts for improved use.
- We expect to contribute, by raising the awareness of the climate change dimension, to the better integration of climate information into the decision making process in both countries. Likewise, we expect to inform a wide array of stakeholders on the existence and potential of seasonal climate forecasts. Thus, in moving towards decentralization and integrated watershed management, both countries will perform better with more informed and educated stakeholders.
- We will improve collaboration between social scientists and different groups of stakeholders like e.g., decision-makers, water managers, engineers, farmers.
- Finally, the project will produce a research report that considers current forms of dissemination of drought and flood related information and their relevance (or lack thereof) for use of climactic forecasting information in policymaking and management of water resources.

B. This research builds on two previously NOAA funded projects about the use of seasonal climate information in Brazil (PI Maria Carmen Lemos) and a study comparing Brazil and Chile (PI Tim Finan). It also builds upon research on the use of seasonal climate forecasting by water managers in the United States (PI Steve Rayner) as well as on the CLIMAS regional assessment (RISA/OGP) (PI Jonathan Overpeck).

C. By building knowledge on the use of climate forecasts by a specific group of decisionmakers (water managers), this research will contribute:

a. To understand how such actors use information or perceive potential use of this kind of information in the future. Detailed knowledge of data use, in turn, will improve understanding of adaptive capacity of different water-related systems (reservoir management, electricity, irrigation, etc) both to climate as well as to other stressors such as increased demand, multi-uses, etc.
b. To better understand current institutional arrangements as a means to assess their 'fit', adaptability and effectiveness to plan and respond to global change. The study's focus on institutional analysis in a comparative perspective (both within countries and across countries) will significantly improve our understanding of the role of institutions (both formal and informal) and institutional adaptation in water management. This knowledge in turn, can critically inform the design and development of decisionmaking tools. Only by understanding how decisionmakers make decisions can we develop 'usable' tools.
c. To assess the role of climate information in policymaking and what can be done to expand and strengthen its influence in proactive governmental planning.